Evaluation of wastewater effluents and It's Effects on AL-WARAR Canal

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ABSTRACT.

The research evaluated the wastewater effluents , Two pump stations discharged directly without any treatment in AL-WARAR Canal in Ramadi City ,located in the southern bank of the Canal . These effluents collects the storm water from the residential area , the drainage open channel which bypassing by septic tanks of domestic wastewater , bypassing from septic tanks of domestic wastewater.

Laboratory Tests out on (December 2010 to May 2011) for the Canal (upstream) , wastewater effluents, and Canal (downstream) to determine the quality characteristics and the wastewater effects upon the AL-WARAR Canal .

The results show an increase in almost concentrations of characteristics compared to the Iraqi Standards NO. (25 –B1) in (1967) of the conservation of water resources , where the Bio-chemical oxygen demand , chemical oxygen demand and Total Bacterial Count were increased by (11, 9.7 and 535) times respectively. According to the organic load , the wastewater effluents classified as low strength . This study shows that the value of the reaction constant rate (k_1) and Reaeration constant rate (k_2)were about (0.187/day) and (0.556 /day) respectively .

Two stations downstream were located to determine the wastewater effects upon the Canal , Dissolved Oxygen was measured and calculated by using (STREETER –PHELPS) equations , then Sag curve of AL-WARAR Canal was determined .In spite of that the wastewater effluent does not comply with the Iraqi Standards discharged into water resources NO. (25 – B1) in (1967) , AL-WARAR Canal still comply with the Iraqi standards (NO. 25-A1) in (1967) of the conservation of water resources by the effect of self-purifications.

Key Words : Evaluation , wastewater , AL-WARAR ,Iraqi Standards, Ramadi city .

1. INTRODUCTION.

The availability of water supply adequate in terms of both quantity and quality is essential to human existence. Early people recognized the importance of water from a quantity viewpoint. Recognition of the importance of water quality developed slowly. It was not until the mid-nineteenth century that the relationship between human waste , drinking water and disease was documented .

The biological , chemical and medical sciences developed were methods available to measure water quality and to determine its effects on human health and well-being

In modern societies proper management of wastewater is necessary , not an option . [1]

According to (WORLD HEALTH ORGANIZATION) , each day some (30000) people die as a result of water related disease . In developing countries (80%) of all illness is water-related. A quarter of children born in developing countries have died before the age of five, the great majority is a result of water-related disease . [2]

Typical composition of untreated domestic wastewater as found in wastewater collection system are reported in **Table (1)** [3]

There are many researchers who study the effects of wastewater on streams, Canals and lakes . (ADEL and et al) evaluate the (Wady Eqab) wastewater effluent and its effects upon Tigris

Canal within Mosul city , this effluent represents a mixture of industrial and domestic wastewater , which is discharged directly in Tigris Canal .The study shows that the suspended solids ,and other impurities concentration for Canal effluent increased by different percentage and some exceeds (34) times. However the Canal is still clear and within the Iraqi standards for conservation of water resources.[4]

(Al-Eid) measure the five day - biochemical oxygen demand , total suspended solids ,pH –value and temperature in four districts of Baghdad city, Z –value ,which is an index of (H_2S) and odor generation has been calculated ,it has been found that Z value was (25000) or more than (82%) of the network ,which is an indication that (H_2S) and odor generation is very high. [5]

(Fahad) studies the middle sector of AL-Masab AL-Aam Canal within AL-Nasyriah City on November 2000 to October 2001 .The results show monthly flactuation in values of all parameters studied .The pH –value , dissolved oxygen ,and free carbon dioxide concentrations inversely correlated with water temperature .The total alkalinity of water was due to bicarbonate and carbonate .Salinity between (4.2 ,8.4)g/L .[6]

(Husain and AL-Reshawi) study (AL-Rumatha)Canal within AL-Muthana Governorate, from location of south of Dewannia city ,until Al-Muthana water treatment project in AL-Rumatha city . Comprehensive biological tests were carried out to assess the suitability of eater for different uses. Especially the new water treatment project in AL-Rumatha city which lies on this Canal , The results show that the Canal contains three types of bacteria E-Coli, Ores and Parasite .[6]

(Ali) evaluates the (Khosar) Canal water quality which disposes its waste directly into tigris Canal within Mosul city. The results showed an increase in the phosphate concentration by (5) times , the bio-chemical oxygen demand increasee by (1.5 – 1.48) times compared to the Iraqi standard No. (25-B1)in (1967 of conservation of water resources .despite that , the Tigris Canal water remained within Iraqi standard No.(25A1) in (1967) of conservation of water resources .[7]

2. OBJECTIVE OF STUDY.

The research aimed to :

1- Determine the (upstream)AL-Warar Canal water quality characteristics .
2- Locate the wastewater effluent points and its characteristics.
3- Determine the characteristics of AL-Warar Canal water quality.
4- Determine the (downstream) characteristics of AL-Warar Canal water quality.
5- Study the effects of wastewater effluents on the Canal .
6- Suggest the solutions to conserve AL-WARAR water quality.

3. STANDARDS LIMITATIONS OF EFFLUENT.

Table (2) shows the standard limitation of discharged wastewater effluent to water resources.

4. AREA.

AL-Warar Canal links between Euphrates Canal and Habaniyah lake within Ramadi city , Al-Warar Control regulator represents the upstream of the AL-Warar Canal ,free along (18.4) Kilometer until downstream of AL-Habaniyah Lake. The network exists for storm water, but there are drain channel linked with network ,in addition to the bypassing of domestic wastewater from the residential areas .

There are two pump stations discharged untreated mixture of storm water and (Exceeded and irregularities domestic wastewater from the south bank) directly to AL-Warar Canal . **Fig. (1)** shows Areal picture of the study area and sketch of the site study area.

5. MATERIALS AND METHODS.

The Plan of study includes , selecting the wastewater effluent stations and extra stations to study the effects of wastewater upon AL-Warar Canal , which was (5) stations, W, W1, W2, W3 and W4 for AL-Warar ,which represent `upstream station , effluent point No. 1 , effluent point No. 2, checking point No. 1 and checking point No. 2 respectively. Then the researcher calculates the flow, velocity for each wastewater and Canal , collects a samples of (5) stations, in addition two other points (m1 and m2) which are the mixing point of wastewater and Canal at (W1 and W2) respectively .The samples is taken according to standard specifications(APHA, AWWA and WPCF, 1985),three samples for each stations each two weeks on (December 2010 to May 2011), and carried in the Engineering College of Al-Anbar University with help of the Laboratories Directorate of Environment in Al-Anbar . Then,the researcher measures a specific characteristics of samples such as ,pH, Temperature , Dissolved Oxygen , BOD5 ,COD, Total Suspended Solids , Nitrates , Phosphates ,Sulfates and Total Plate Count of Bacteria (TBC) by using (Standard Method) [8]. Then , the researcher compare the concentration with the Iraqi standard limitations to evaluate the wastewater and AL-Warar water quality. Finally , the researcher suggest the solutions to conserve AL-WARAR water quality.

6. OXYGEN SAG CURVE.

The oxygen deficit in a stream is a function of both oxygen utilization and Reaeration .The oxygen deficit is represented mathematically by:

$$D = C_S - C \tag{1}$$

Where D is the dissolved oxygen deficit and Cs and C are the equilibrium (saturation) concentration and actual oxygen concentration , respectively. The units of all terms are milligrams per liters of oxygen.

The rate of change in the dissolved oxygen deficit at time (t) due to the BOD is first – order reaction proportional to the oxygen equivalent of the remaining organics is :

$$r_D = K_1 . L_t \tag{2}$$

Where(r_D) is the rate of change in the dissolved oxygen deficit due to oxygen utilization, L_t is the remaining organics .The reaction rate constant (k_1) is derived from laboratory tests on the wastewater , and adjusted for temperature change as follow :

$$K_T = K_{20} (1.047)^{T-20} \tag{3}$$

The rate of Reaeration is first – order reaction with respect to the magnitude of the oxygen deficit . this is expressed mathematically by :

$$r_R = -K_2 . D \tag{4}$$

Where (r_R)is the rate at which oxygen becomes dissolved from the atmosphere , D is the oxygen deficit , and (K_2) is a Reaeration rate constant that is system - specific. factors affecting (k2) include stream turbulence (a function of velocity and channel characteristics),surface area, water depth and temperature . Temperature corrections are made by equation (3) replacing a value of (1.047) by (1.016).(peavey) the Reaeration rate constant calculated by the O'Conner and Dobbins equation[9] , and suggessted by (Cover)[10]:

$$K_2 = \frac{3.9U^{0.5}\sqrt{(1.037)^{(T-20)}}}{H^{1.5}} \quad (5)$$

Where U = the average stream velocity(m/sec) , H = the average depth (m) and T= temperature (°C). Inspection of equations (2) and (4) shows that these two processes have opposite effects on the deficit . This is shown graphically in **fig. (2)** . the rate of change in the deficit is the sum of the two reactions[1]:

$$\frac{dD}{dt} = r_D + r_R \quad (6)$$

And the final form is :

$$D_t = \frac{k_1 L_o}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right) + D_o e^{k_2 t} \quad (7)$$

Where (t) represents the time of travel in the stream from the point of discharge ,and Lo is ultimate BOD .

The most important point on the oxygen sag curve of the streams is often the point of lowest concentration because this point represents the maximum impact on the dissolved oxygen due to wastewater discharge . this point is called critical deficit (Dc) , and the time of travel to this point is termed the critical time (tc) , and can found from the equations :

$$D_c = \frac{k_1}{k_2} L_o e^{-k_1 t_c} \quad (8)$$

$$t_c = \frac{1}{k_2 - k_1} \ln\left[\frac{k_2}{k_1}\left(1 - D_o \frac{k_2 - k_1}{k_1 L_o}\right)\right] \quad (9)$$

Equations (7-9) are called (streeter – Phelps Esq.'s) [11].

6.1. Reaction Rate Constant (k_1) And Reaeration Rate Constant (k_2) Calculations.

The reaction rate constant (k_1) is derived from laboratory tests on the wastewater ,the value of (k_1) and ultimate BOD(L_o) are determined from a series of BOD measurements. There are several ways to determine (k_1) and (UBOD) from the results of a series of BOD measurements, including the least squares method ,the method of moments (Moore et al,1950), the daily difference method(Tsivoglou,1958),the rapid-ratio method(Sheehy,1960), the Thomas method(Thomas,1950) , and the Fujimoto method (Fujimoto ,1961). small variation in the value of (k_1) will have fairly large effects upon dissolved oxygen concentration in the Canal [12]. **Table (3)** different values of reaeration rate constant

according to nature of the water resoources [13] In this research the least squares method has been applied to calculate the reaction rate constant .[3]
Reaeration rate constant (k_2) is calculated by using equation (5) .

6.2.Determining Hydraulic Characteristics.

In this stage some hydraulic characteristics for both Canal and wastewater effluents were calculated or estimated such as average Flow rate , average mean velocity , average depth of Canal (H) . the average flow of Canal (Qr) is determined by determining average mean velocity of the Canal (U) multiplied by the average depth of the Canal for each section.
The wastewater characteristic such as the average flow rate (Qw) was calculated from calculating the volume of collecting tank of the pump stations divided by the time operation daily.The pump stations operate twice a day each (12) hours for abour one hour . (8:00 A.M and 8:00 P.M).
The critical condition of the Canal occurs during dry weather (summer) because the low flow rate (Qr) and concentrated wastewater.
In this research the least squares method has been applied to calculate the reaction rate constant .[3]
Reaeration rate constant (k_2) is calculated by using equation (5)
statistical software was used (Statica6.0) in the calculation of standard deviation, the highest value, less the value of the average for each station of the Canal (w), and the wastewater effluent stations (w1) and (w2).

7.RESULTS AND DISCUSSION.

7.1. Water Quality Characteristics.

The average laboratory tests results for samples of stations the study was carried on December 2010 – May 2011. **Tables (3 to 10)** and the **Figs. (3 to 13)** show the characteristics of AL-Warar Canal water quality at (upstream) station (W) , the first wastewater Effluent station (W1) , the mixing point of Canal and the first effluent, the second wastewater Effluent station (W2), the mixing point of Canal and effluent 2 , the station (W3) about (1000) meter downstream of effluent 2 and the station (W4) about (2000) meter downstream of effluent 2. The results compared with the Iraqi Standards limitations (No. 25-A1) of the conservation of water resources show increasing in Bio-chemicals oxygen demand through the study period and deceasing in Dissolved oxygen for Canal in December , April and May, that the Canal characteristics exceeding the Iraqi Standards limitations (No. 25-A1) of the conservation of water resources .

7.1.1. AL-Warar Canal Water Quality .

The average laboratory tests results for samples of station (W) are shown in **Table (4)** , and **Figs.(3-10)** Which show the characteristics of AL-Warar Canal water quality at (upstream). According to the results and compared with the Iraqi Standards limitations (No. 25-A1) of the conservation of water resources , The results show that the Canal water quality has acceptable concentrations of (pH, COD, NO_3, SO_4, Temperature and Chlorides according to the Iraqi Standards limitations. While the Dissolved Oxygen , BOD5 , T.S.S , and TCB not comply with the Iraqi Standards limitations .The upstream Canal water quality is degraded by storage water by (AL-WARAR Regulator) , and the minimum flow rate through dry weather.
Table (5) shows the descriptive statistics of AL_Warar Canal water before the effluent discharge.

7.1.2 . Effluents Wastewater Quality .

Tables (6 and 7) and **Figs. (3-10)** show the results of the effluent wastewater (W1 and W2) , Which a brief explanation of each element of water quality.

The results show that the value of (DO,BOD_5, COD, TSS,PO_4, SO_4, Cl and TBC do not comply with the Iraqi Standards limitations. The pH –value and Temperature comply with the Iraqi Standards limitations . The results show that the wastewater effluents have (low strength) (source) , and have acidity characteristics due to microorganisms effects **Table (8)** shows the descriptive statistics of the effluent discharge (W1 and W2).

7.1.3. Downstream Water Quality .

Table (9 and 10) and **Figs. (3-10)** show the results of the Canal water quality (W3 and W4) ,The results show that the Canal water downstream station (W3 and W4) have acceptable concentrations of (pH, DO, COD, No and Temperature according to the Iraqi Standards limitations. The BOD,TSS, PO,SO Cl , and TBC do not comply with the Iraqi Standards limitations . **Table (11)** shows the descriptive statistics of AL-Warar Canal water before the effluent discharge.

7.2. The Hydraulic Characteristics .

Series of BOD test has been applied to determining the reaction rate constant (k_1) , which is derived from laboratory tests on the wastewater. In this research the least squares method has been applied to calculate the reaction rate constant. The value of (k_1) and ultimate BOD(Lo) are determined from a series of BOD measurements. The Canal average velocity measured by current meter ,which is about (0.1)m/sec, the average depth was (1.7) meter ,the average Canal flowrate was (4.6) m3/sec, the average of first wastewater effluent flowrate was (0.15) m^3/sec , the average of second wastewater effluent flowrate was (0.106) m^3/sec).[14].

The reaction constant rate for the wastewater was determined by (0.187) per day . the Reaeration constant rate for the Canal was (0.566) per day.

7.3. Effects of Wastewater on Canal and Dissolved Oxygen Sag Curve.

Table(12) and **Figs.(14 -19)** show that the Canal water downstream station (W3 and W4) have acceptable concentrations of dissolved oxygen .There are fluctuation between the measured and calculated dissolved oxygen because there are assumptions of these equations such as completely mixing between wastewater and Canal , homogenous distribution along cross-section of the Canal ,the Reaeration is only from the air .

Although that the Canal has capability of repurify by self-purification such as (dilution , sun light, sedimentation) .

8. CONCLUSION.

1- the Canal water quality (upstream) results show concentrations of pollutants exceeded the Iraqi standard Law No. (25 - a 1) of the conservation of water resources in (1967) for each of the (BOD5) and total suspended solids and total bacterial count , contaminants studied, while others Comply with the Iraqi Standards.

2- The wastewater effluent quality results show exceeded concentrations of pollutants exceeded the Iraqi standard Law No. (25 - b 1) of the conservation of water resources in (1967) for most pollutants studied except temperature and pH remained within the specification above.

3- The downstream Canal water quality results show most of the pollutants studied do not comply with the Iraqi standard Law No. (25 - a 1) of the conservation of water resources in

(1967), except the temperature degree , pH , (COD) , the concentration of dissolved oxygen , the nitrate ion remained within the specification above.

4- Effluent wastewater discharges can be classified on Al-Warar Canal according to Bio-chemical oxygen demand for the concentration of oxygen at mean value of (95) mg / L as (low strength).

5- the reaction rate Constant value of the waste water was (0.187 / day), which falls within the values of decomposition of household waste.

7- Reaeration rate constant value of Canal water was (0.0.566 / day).

9. RECOMMENDATIONS.

1- Treatment the wastewater before discharged directly into the water resources to comply within the Iraqi standard Law No. (25 - b 1) of the conservation of water resources in (1967)

1- Study the effect of nutrients (nitrates and phosphorus) on Lake Habbaniyah and other organisms such as fish and plants.

2- Need to give an appropriate share of water, including reducing the concentration of pollutants in the event of continuing operations of discharging without treatment.

3- The establishment of an environmental awareness seminars for citizens to alert the risks and environmental impacts of pollution on water resources.

10. FUTURE STUDY.

1- Design wastewater Treatment plant to treat the wastewater before discharging on AL-WARAR Canal .
2- Study some other characteristics of water quality in each of the approaches .

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Table (1): Typical Composition of Untreated Wastewater.

Contaminants	Unit	Concentration		
		Low Strength	Medium Strength	High Strength
Total Suspended Solids	mg/L	120	210	400
Total Dissolved Solids	mg/L	270	500	860
Biochemical Oxygen demand @20^{o}C (BOD_5)	mg/L	110	190	350
Chemical Oxygen demand (COD)	mg/L	250	430	800
Nitrogen (Total as N)	mg/L	20	40	70
Phosphoure (Total as P)	mg/L	4	7	12
Chlorides	mg/L	30	50	90
Sulfates	mg/L	20	30	50
Total Coliform		10^6- 10^8 /100 mL	10^7- 10^{10} /100 mL	10^7- 10^8 /100 mL

Table (2): The Standard Limitation of Discharged Wastewater Effluent to Water Resources.

parameter	pH	D O	(BOD_5)	(COD)	Cl	SO_4	NO_3	PO_4	T	TSS
Canal rivulet	6.5 – 8.5	> 5 mg/L	<5 mg/L	<100 mg/L	200 mg/L	400 mg/L	15 mg/L	0.4 mg/L	<35 ^{o}C	60 mg/L

Table (3): Reaeration Rate Constant [13].

Type of watercourse	(K_2)@(20^{o}C)per day
Sluggish stream	0.23 – 0.35
Large stream ,small velocity	0.35 – 0.46
Large stream ,normal velocity	0.46 – 0.69
Swift stream	0.69 – 1.15
Rapids	>1.15

Table (4): The Average Laboratory Results of Al-Warar Canal at Upstream.

Parameter / Month	pH	T °C	D.O mg/L	BOD_5 mg/L	COD mg/L	T.S.S mg/L	$NO_3^{=}$ mg/L	PO_4 mg/L	SO_4 mg/L	Cl^- mg/L	T.B. C $\times 10^3$ لكل 100مللتر
Dec	7.82	21	4.99	8.94	18.77	21.45	2.3	0.21	411	187	10
Jan	7.84	12	6.37	6.82	11.18	37.96	2.63	0.15	425	196	6
Feb	7.92	13	5.89	7.58	18.07	25.6	2.33	0.22	412	209	5
Mar	7.93	18	5.38	7.76	17.3	55.32	3.1	0.31	473	234	7.5
Apr	7.9	19	4.56	8.64	19.53	69.56	3.94	0.2	514	279	12.5
May	7.73	23	4.38	12.25	22.89	74.6	2.75	0.48	542	240	15
Iraq.Sd.	6.5-8.5	—	>5	<5	<100 mg/L	60 mg/L	15	0.4	200	200	—

Table (5): The Statistical Descriptive Results of Al-Warar Canal at Upstream.

element	Mean	Maximum	Minimum	Standard Deviation
pH	7.85	7.93	7.73	0.076
T	17.66	23	12	4.366
DO	5.261	6.37	4.38	0.772
BOD_5	8.665	12.25	6.82	1.914
COD	17.95	22.89	11.18	3.842
TSS	47.415	74.6	21.45	22.50
NO	2.841	3.94	2.3	0.613
PO	0.261	0.48	0.15	0.118
SO	462.83	542	411	56.019
Cl	224.166	279	187	33.937
TBC	9333.33	15000	5000	3894.44

Table (6): The Average Laboratory Results of The First Effluent (W1).

Parameter / Month	pH	T °C	D.O mg/L	BOD_5 mg/L	COD mg/L	T.S.S mg/L	$NO_3^=$ mg/L	PO_4 mg/L	SO_4 mg/L	Cl^- mg/L	T. B. C لكل $\times 10^6$ 100مللتر
Dec	7.48	20	0	87	186	285	12.3	3.7	739	1540	36
Jan	7.3	11	0	63	126	271	4.52	4.2	735	1123	46
Feb	7.2	11.5	0	88	113	256	4.38	4.1	869	968	50
Mar	7.28	19.5	0	75	171	264	4.61	6.8	763	896	55
Apr	7.4	20	0	128	217	286	5.3	2.4	856	965	61
May	7.34	24	0	114	245	325	6.5	4.7	856	864	60
Iraq.Sd	6-9.5	–	>5	<40	<100	60	50	3	—	—	—

Table (7): The Average Laboratory Results of The First Effluent (W2).

Parameter / Month	pH	T °C	D.O mg/L	BOD_5 mg/L	COD mg/L	T.S.S mg/L	$NO_3^=$ mg/L	PO_4 mg/L	SO_4 mg/L	Cl^- mg/L	T.B.C لكل $\times 10^6$ 100مللتر
Dec	7.44	20	0	76	172	314	8.7	5.6	695	1136	28
Jan	7.56	11	0	71	148	283	5.1	4.3	786	1327	49
Feb	7.18	11	0	79	156	246	3.4	3.1	721	1154	49
Mar	7.34	19	0	83	164	274	3.89	5.5	738	925	56
Apr	7.16	20	0	142	198	243	4.8	3.1	752	856	58
May	7.25	24	0	135	215	294	5.85	5.1	772	895	56

Table (8): The Statistical Descriptive Results of The Wastewater Effluents (W1 and W2).

element	Standard Deviation	Maximum	Minimum	Mean
pH	0.120564	7.56	7.16	7.324166667
T	5.030965	24	11	17.58333333
DO	0	0	0	0
BOD_5	27.1911	142	63	95.08333333
COD	38.59453	245	113	175.9166667
TSS	25.02892	325	243	278.4166667
NO	2.474714	12.3	3.4	5.779166667
PO	1.243569	6.84	2.43	4.385
SO	57.45749	869	695	773.5
Cl	210.997	1540	856	1054.083333
T.B.C	9902556	61000000	28000000	50333333.33

Table (9): The Average Laboratory results of Al-Warar Canal at Downstream (W3).

Parameter / Month	pH	T °C	D.O mg/L	BOD_5 mg/L	COD mg/L	T.S.S mg/L	$NO_3^=$ mg/L	PO_4 mg/L	SO_4 mg/L	Cl^- mg/L	T.B.C لكل $\times10^6$ 100مللتر
Dec	7.42	21	5.1	13.4	26.8	51	2.7	1.7	520	225	0.5
Jan	7.63	11.9	6.12	13.1	28.6	55	2.6	1.1	538	248	0.7
Feb	7.55	11.9	6.7	12.8	42.4	32	2.3	1.2	507	226	1.6
Mar	7.66	18	6.45	12.4	27.8	49	2.35	1.4	484	232	1.8
Apr	7.65	18	4.48	11.5	41.5	44	2.24	1.1	462	215	2.2
May	7.6	23	4.36	17.1	44.3	68	2.35	1.8	497	235	1.7
I.S	6.5-8.5	—	>5	<5	—	—	15	0.4	200	200	—

Table (10): The Average Laboratory results of Al-Warar Canal at Downstream (W4).

Parameter / Month	pH	T °C	D.O mg/L	BOD_5 mg/L	COD mg/L	T.S.S mg/L	$NO_3^=$ mg/L	PO_4 mg/L	SO_4 mg/L	Cl^- mg/L	T.B.C $\times10^6$ لكل 100مللتر
Dec	7.45	21	5.9	12.2	24	45	2.55	1.2	497	190	0.4
Jan	7.71	12	6.75	11.8	23.4	42	2.5	1.1	490	205	0.5
Feb	7.65	12	6.84	11.2	35.6	29	2.34	0.9	497	196	1.1
Mar	7.67	18	6.28	10.6	25.1	31	2.13	1.1	415	184	1.6
Apr	7.76	18	5.17	9.78	36.7	35	2.1	1	413	173	1.7
May	7.72	23	4.72	15.6	38.6	45	2.2	1.5	449	211	1.2
I.S	6.5-8.5	–	>5	<5	–	—	15	0.4	200	200	–

Table (11): The Statistical Descriptive Results of Al-Warar Canal at Downstream (W3 and W4).

element	Standard Deviation	Maximum	Minimum	Mean
pH	0.103496	7.76	7.42	7.6225
T	4.356987	23	11.9	17.31667
DO	0.647829	7.6	5.1	6.525
BOD_5	2.047967	17.1	9.78	12.62333
COD	7.748314	44.3	23.4	32.9
TSS	11.37649	68.1	28.9	43.85
NO	0.189129	2.7	2.1	2.363333
PO	0.273345	1.77	0.94	1.254167
SO	38.9268	538	413	480.75
Cl	22.74896	248	173	211.6667
TBC	605279.8	2200000	400000	1250000

Table (12): Measured And Calculated Dissolved Oxygen of The Canal.

Month		C_s	Canal	M1	M2	W3	W4
Dec.	Measured		4.99	4.7	4.6	5.1	5.9
	Calculated	8.4	4.99	4.83	4.53	4.4	4.61
Jan.	Measured		6.37	5.6	4.8	6.1	6.75
	Calculated	9.2	6.37	5.98	5.73	5.61	5.86
Feb.	Measured		5.89	5.4	5.6	6.7	6.84
	Calculated	9.3	5.89	5.70	5.42	5.36	5.6
Mar.	Measured		5.38	5.3	5.32	6.45	6.28
	Calculated	9.1	5.38	5.21	5	4.85	5.14
Apr.	Measured		4.56	4.24	3.97	4.48	5.17
	Calculated	8.85	4.56	4.1	3.82	4	4.31
May	Measured		4.38	4.1	3.73	4.36	4.72
	Calculated	7.75	4.38	3.92	3.54	3.98	4.13

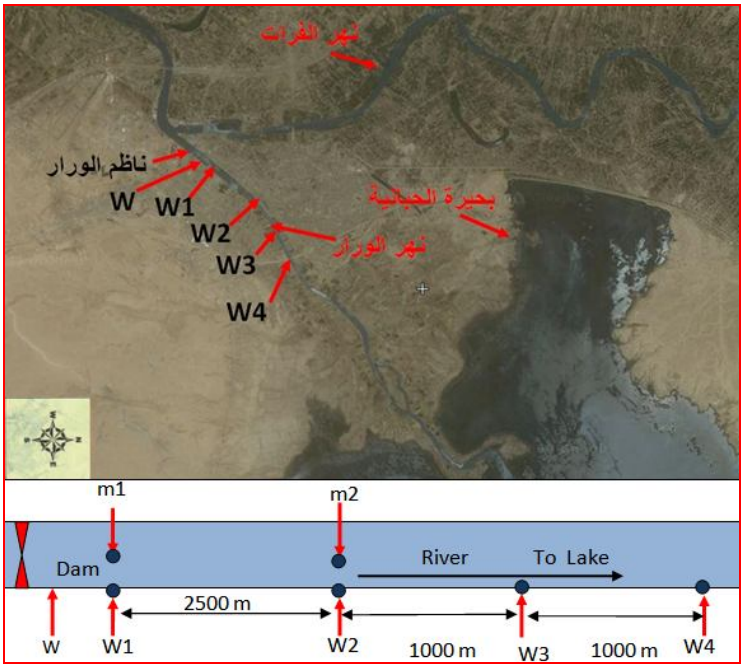

Figure (1): Show Areal Picture of The Study Area.

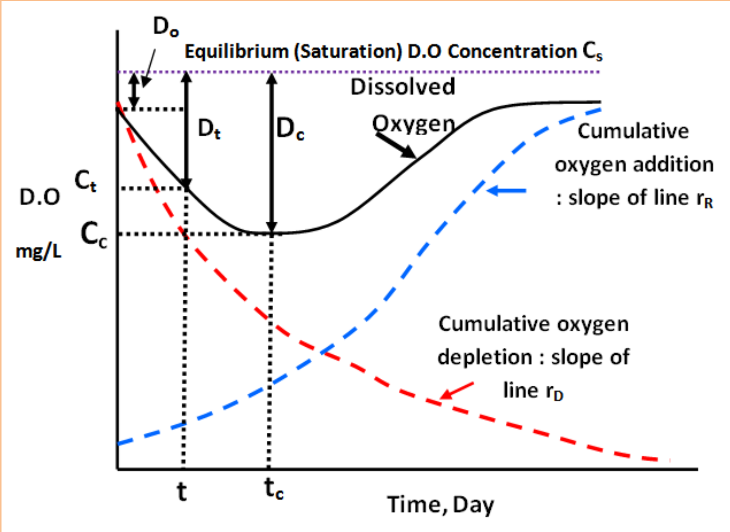

Figure (2): Characteristics of The River Oxygen Sag Curve.

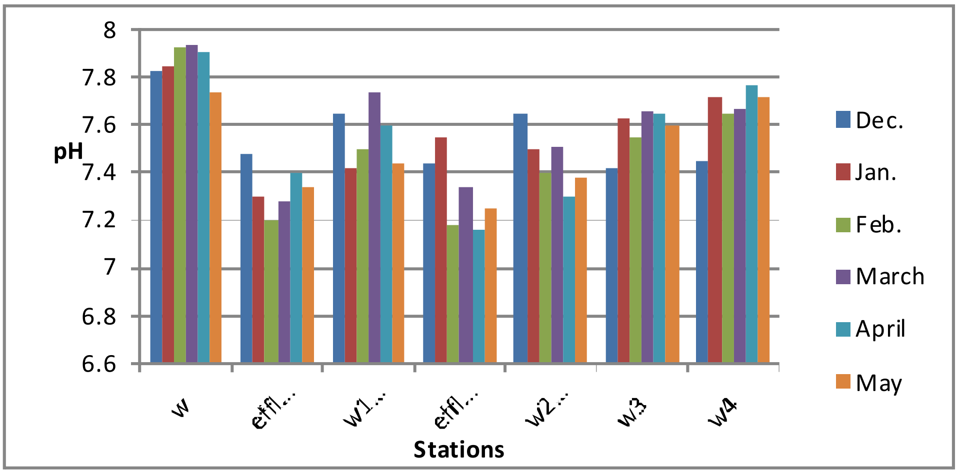

Figure (3): Show The pH-Value at Stations During Period of Study.

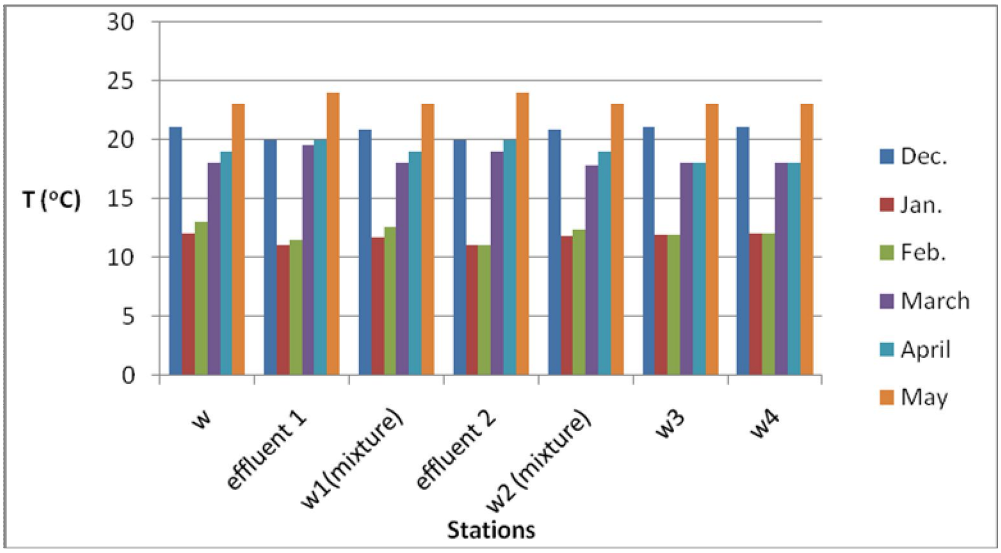

Figure (4): Show The Temperature at Stations During Period of Study.

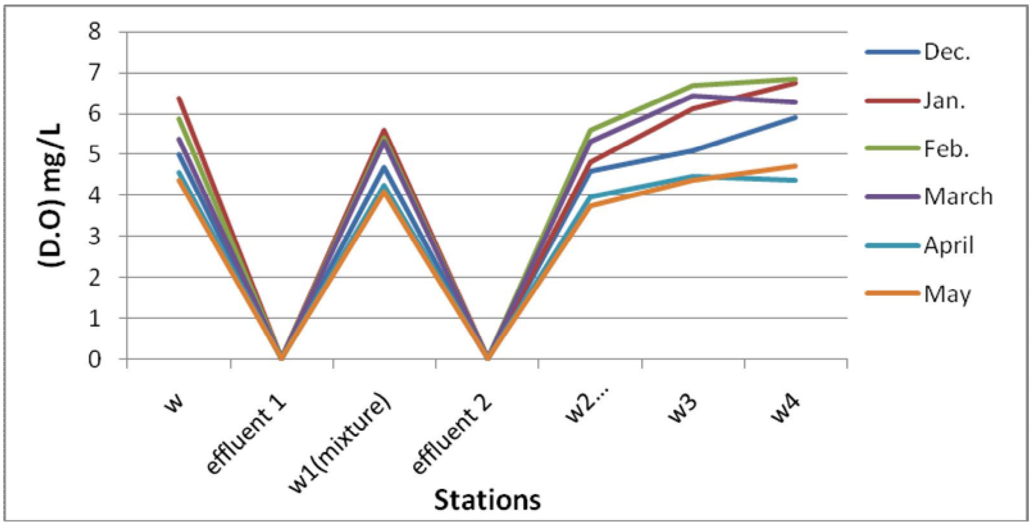

Figure (5): Show The Dissolved Oxygen at Stations During Period of Study.

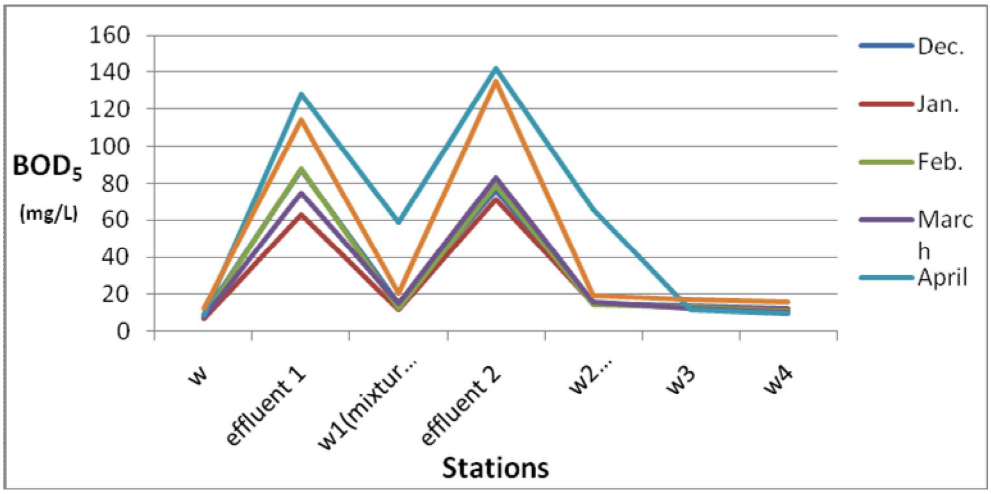

Figure (6): Show The Bio-Chemical Oxygen Demand at Stations During Period of Study.

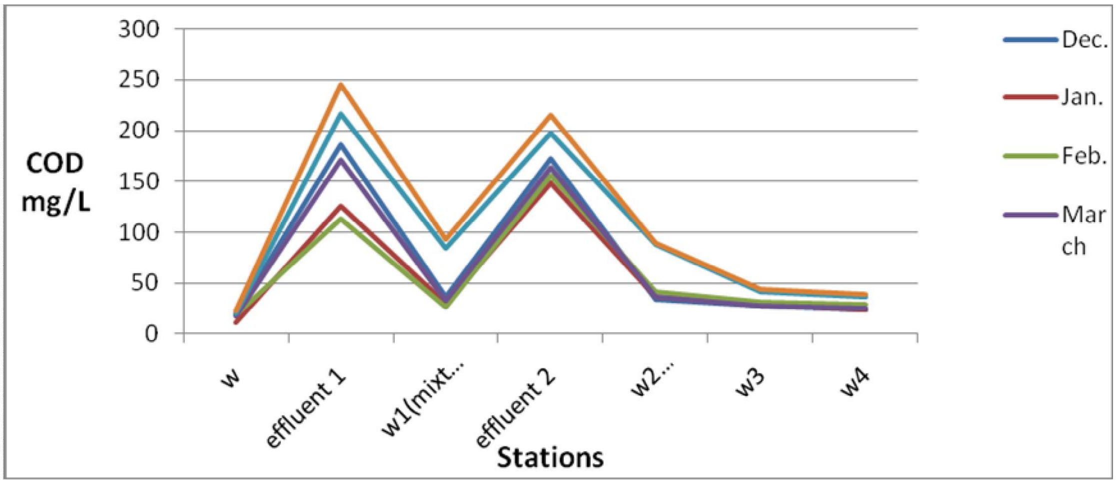

Figure (7): Show The Chemical Oxygen Demand at Stations During Period of Study.

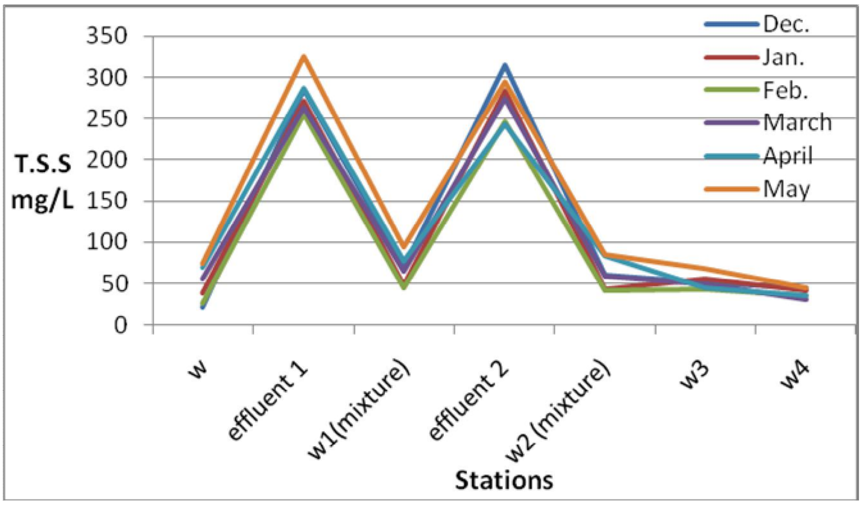

Figure (8): Show The TSS at Stations During Period of Study.

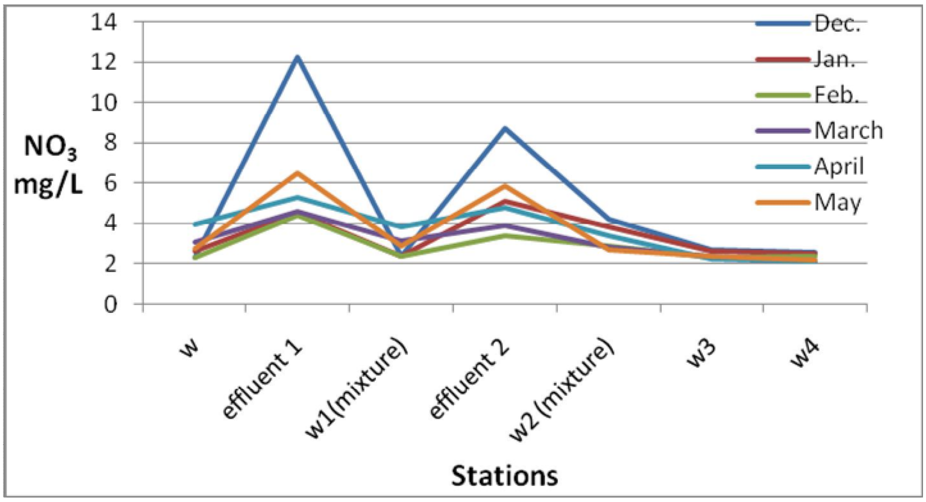

Figure (9): Show The Nitrates at Stations During Period of Study.

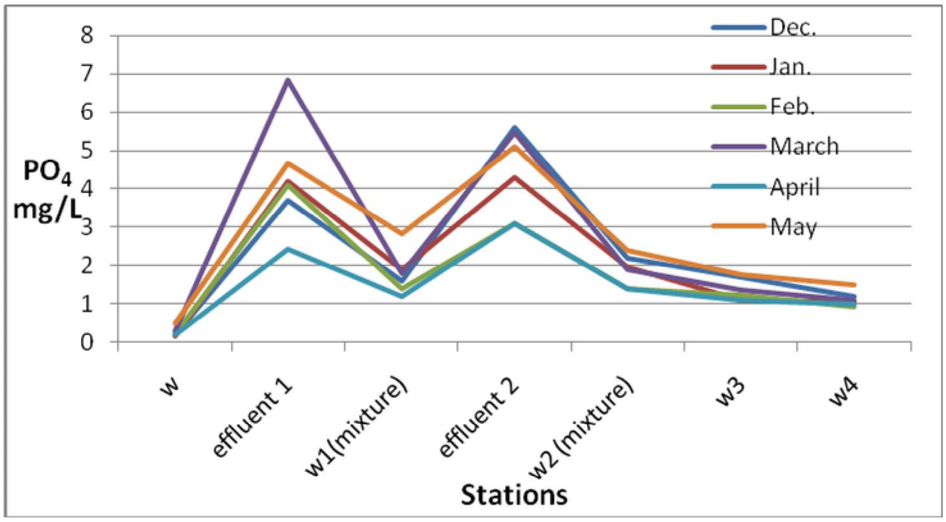

Figure (10): Show The Phosphates at Stations During Period of Study.

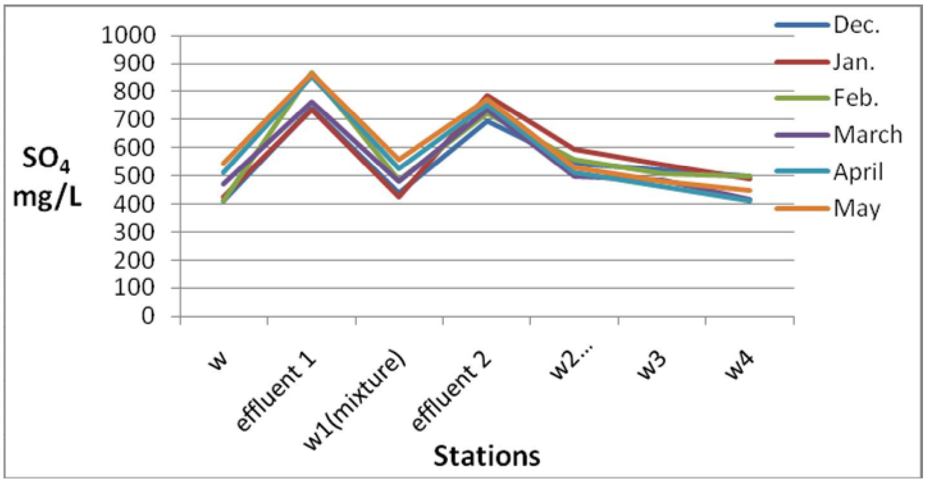

Figure (11): Show The Sulfates at Stations During Period of Study.

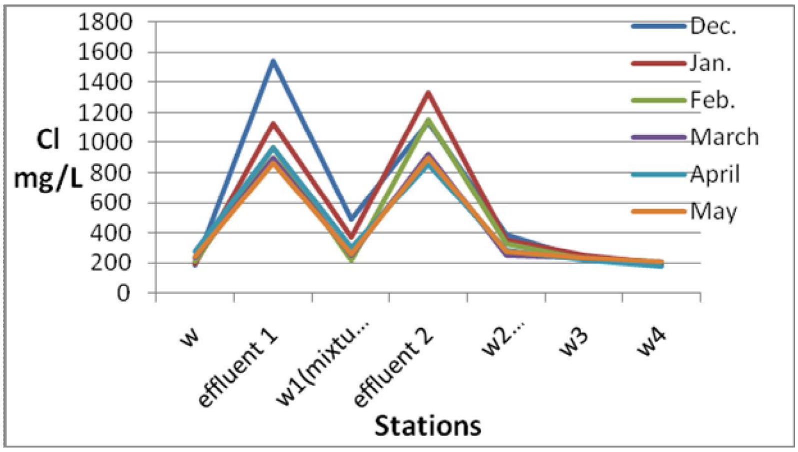

Figure (12): Show The Chlorides at Stations During Period of Study.

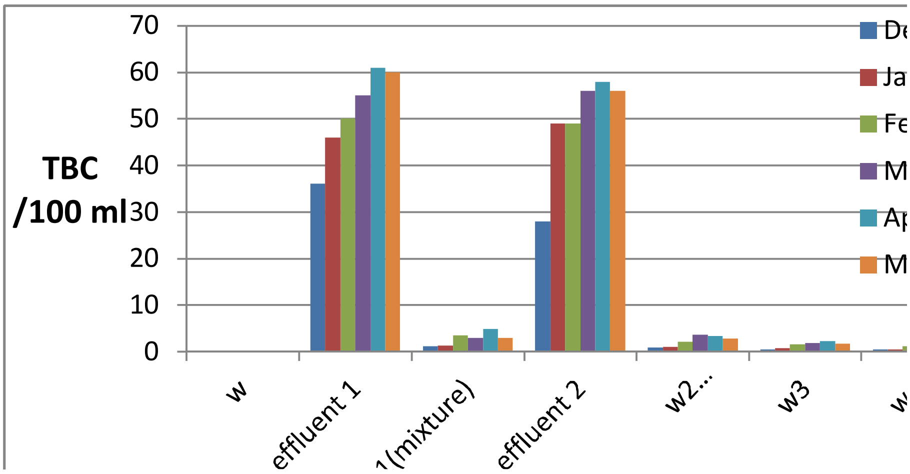

Figure (13): Show The TBC at Stations During Period of Study.

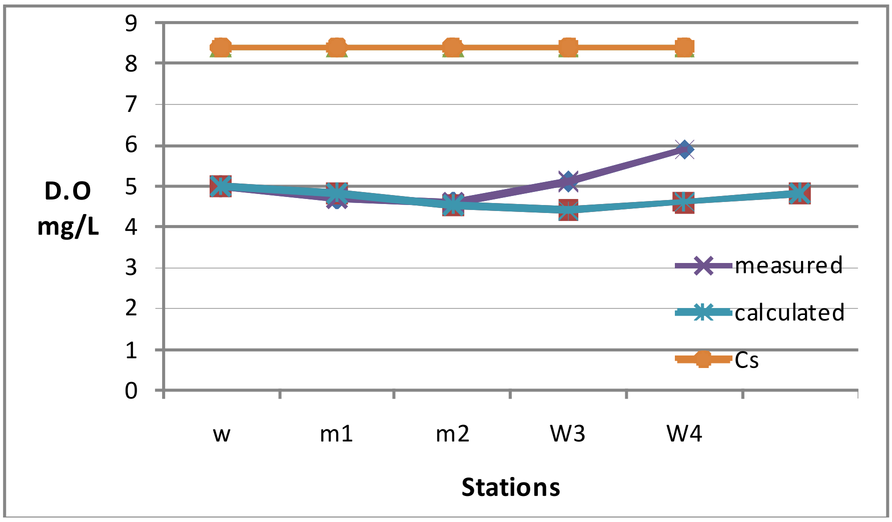

Figure (14): Show The Measured and Calculated DO at Stations During December.

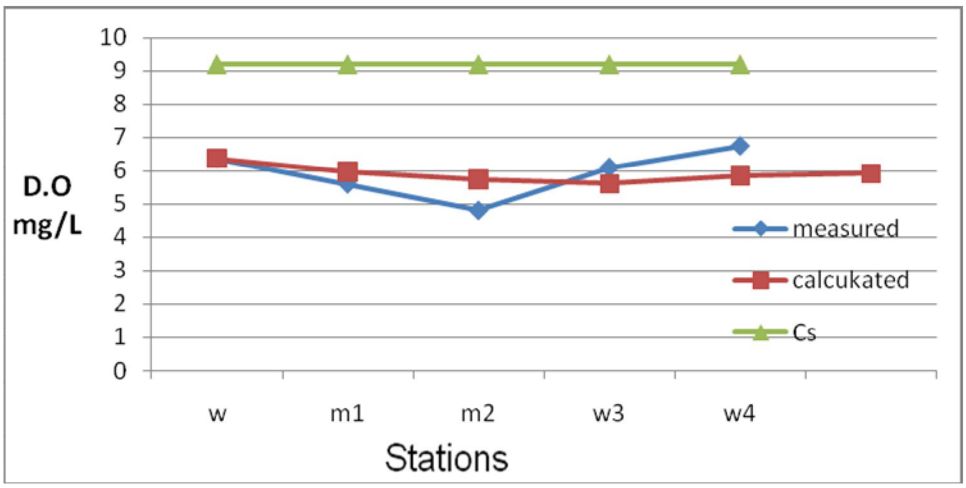

Figure (15): Show The Measured and Calculated DO at Stations During January.

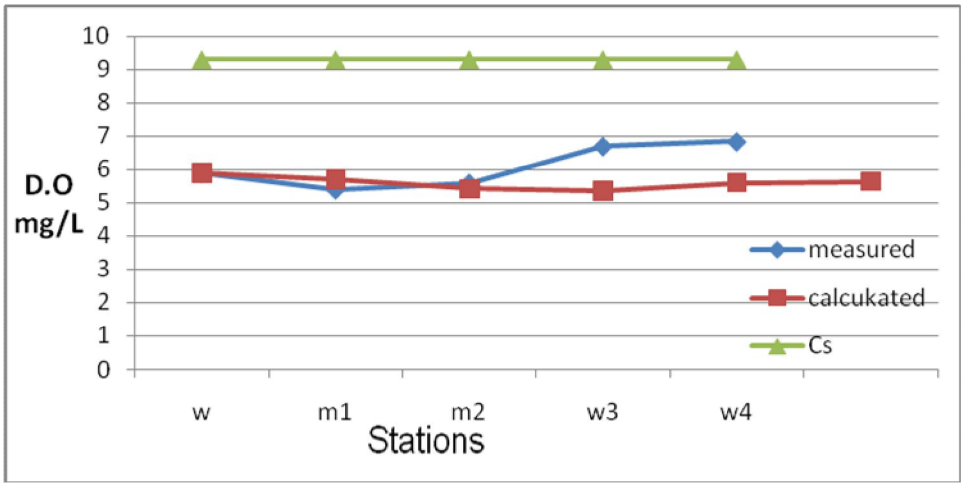

Figure (16): Show The Measured and Calculated DO at Stations During February.

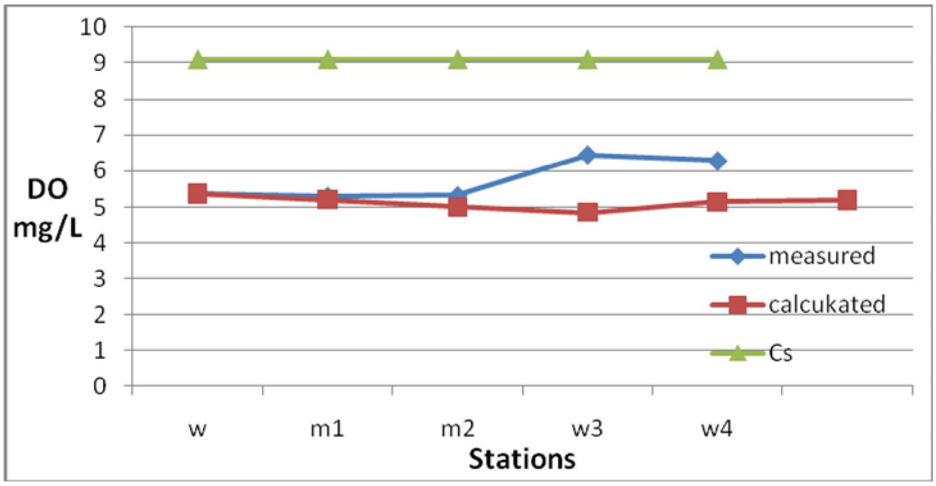

Figure (17): Show The Measured and Calculated DO at Stations During March.

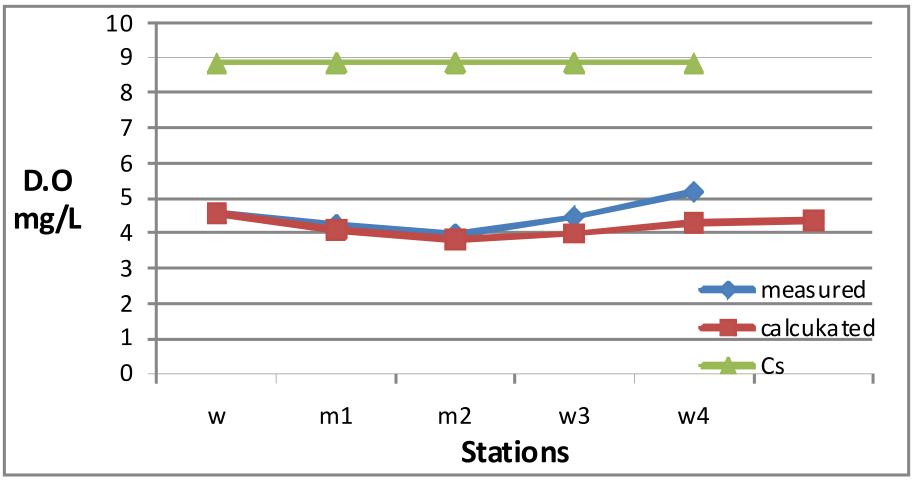

Figure (18): Show The Measured and Calculated DO at Stations During April.

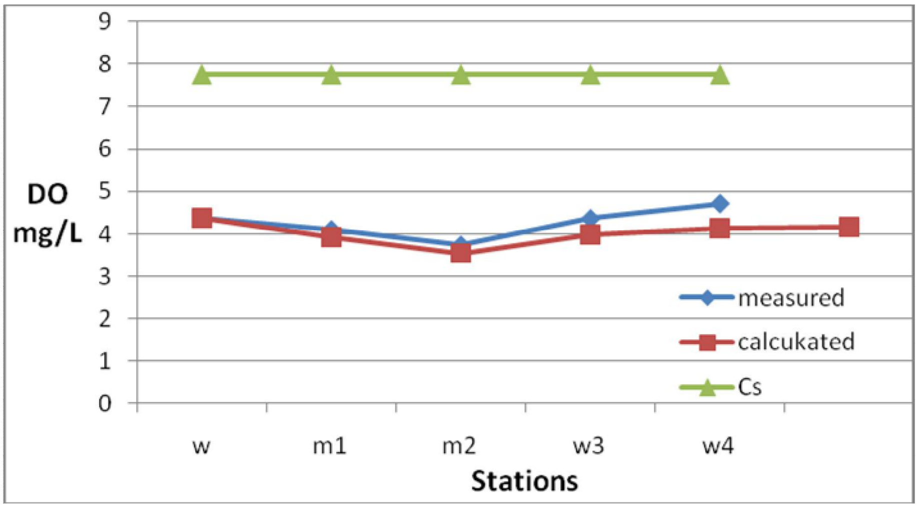

Figure (19): Show The Measured and Calculated DO at Stations During May

تقييم نوعية المطروحات السائلة وتأثيرها على قناة الورار

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الخلاصـة .

تم في هذا البحث تقييم نوعية المطروحات السائلة المطروحة من محطتين للضخ بصورة مباشرة وبدون معالجة الى قناة الورار في مدينة الرمادي ، تقع نقاط الطرح على الضفة الجنوبية للقناة ، تقوم محطتي الضخ بطرح المياه الملوثة المتجمعة من شبكة مياه الأمطار ، المبازل في المناطق السكنية ، مياه التجاوزات على المبازل من خزانات التعفين والتجاوزات من المناطق السكنية على شبكة مياه الأمطار .

اجريت التجارب المختبرية للفترة ما بين (كانون الأول 2010– وحتى آيار 2011) لنقاط مختارة وهي اعلى القناة (قبل نقاط الطرح)، نقاط طرح المياه الملوثة ، ونقاط اسفل القناة ، وذلك لتحديد الخصائص النوعية لكل من المياه الملوثة ومياه القناة وكذلك دراسة تأثير المياه الملوثة على مياه القناة .

بينت النتائج زيادة في تركيز أغلب الخصائص النوعية التي تم دراستها مقارنة مع قانون نظام صيانة الأنهار العراقية رقم (25–ب1) لسنة (1967) . حيث ازدادت قيمة المتطلب الحيوي للأوكسجين ، المتطلب الكيمياوي للأوكسجين ، وقيمة العدد البكتيري الكلي حوالي (11 ، 9.7، 535) مرة على التوالي تم تصنيف المياه الملوثة إعتماداً على متطلب الأوكسجين الحيوي بأنها ضعيفة ، كما تم حساب كل من قيمة ثابت معدل التفلعل للمياه الملوثة (K1) وثابت معدل التهوية لمياه القناة (K2) وكانت (0.187/يوم) و (0.566 / يوم) على التوالي .تم اختيار محطتين بعد نقاط الطرح لمعرفة تأثير المياه الملوثة على مياه القناة ، حيث تم قياس تركيز الأوكسجين المذاب ، كما تم حسابه بأستخدام معادلات (ستريتر – فيلبس) ، وتم ايجاد منحنى الأوكسجين لقناة الورار . على الرغم من ان المياه الملوثة المطروحة الى قناة الورار لا تتوافق مع قانون نظام صيانة الأنهار رقم (25 – ب1) الا ان الخصائص النوعية لمياه القناة بقيت متوافقة مع قانون نظام صيانة الأنهار رقم (25 – أ1) لسنة (1967) بسبب تأثير عوامل التنقية الذاتية .

الكلمات الرئيسية: تقييم،مياه ملوثة،الورار،المواصفات العراقية،مدينة الرمادي.